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The Commonwealth of Massachusetts

MICHAEL S. DUKAKIS, *Governor*

Executive Office of Manpower Affairs
Howard N. Smith, Secretary

DEPARTMENT OF LABOR AND INDUSTRIES
NICHOLAS ROUSSOS, *Commissioner*

DIVISION OF OCCUPATIONAL HYGIENE
HAROLD BAVLEY, P.E., *Director*

PREVENTION

DETECTION EVALUATION

CONTROL

INDUSTRIAL BULLETIN NO. 5

RULES AND REGULATIONS

for the

Protection of the Health and Safety of Employees from Occupational Diseases

Caused by

IONIZING RADIATION

Effective December 15, 1978

Originating Office

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Department of Labor and Industries, Division of Occupational Hygiene

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RULES AND REGULATIONS RELATIVE TO

IONIZING RADIATION

1. PURPOSE

1.1 It is the purpose of these rules and regulations to state the minimum requirements for the use, handling, processing, application, transfer, storage and removal of all sources, materials, instruments, machines, devices, and equipment which produce, generate or emit ionizing radiation to insure the maximum safety of all persons at or in the vicinity of such ionizing radiation.

1.2 The rules and regulations herein are intended to be in harmony with Federal regulations as they apply.

2. APPLICATION

2.1 These rules and regulations shall apply to and in all places of employment where sources, materials, instruments, machines, devices, and equipment produce, generate, or emit ionizing radiation during the use, handling, processing, testing, application, transfer, storage, or removal thereof.

3. DEFINITIONS

3.1 Airborne Radioactive Material shall mean airborne radioactive material in any form, such as dusts, fumes, vapors, mists, gases, or smokes.

3.2 Agreement State shall mean any state with which the Atomic Energy Commission or the Nuclear Regulatory Commission has entered into an effective agreement under subsection 274b of the Atomic Energy Act of 1954.

3.3 Body Burden shall mean the amount of radioactive material in the body at any time.

3.4 Calendar Quarter shall mean:

(a) a period of not less than 12 nor more than 14 complete consecutive calendar weeks.

(b) a period of three (3) consecutive calendar months. Once he has established the method to be used to determine calendar quarters, no employer shall change his method without prior permission from the Commissioner.

3.5 Commissioner shall mean Commissioner of Labor and Industries.

3.6 Controlled Area shall mean a defined area, access to which is controlled for the purpose of radiation protection.

3.7 Critical Organ shall mean that part of the body that is most susceptible to radiation damage under the specific conditions considered.

3.8 Curie shall mean the standard unit used in measuring the activity of a radioactive substance, and shall be numerically equal to 3.7×10^{10} disintegrations per second. Commonly used sub-multiples of the curie are: the microcurie (one millionth of a curie), μ Ci=3.7×10^{4} disintegrations per second, and the millicurie (one thousandth of a curie), mCi=3.7×10^{7} disintegrations per second.

3.9 Department shall mean the Department of Labor and Industries.

3.10 Dose shall mean the quantity of radiation absorbed, per unit of mass, by the body or by any portion of the body.

3.11 Employer (of an installation) shall mean the person or organization having by law the administrative control of a source of radiation located within the confines of the installation, whether as proprietor, lessee, or otherwise.

3.12 Exempted as used in Sections 14.1 (h), (i), (j), (k) shall mean radioactive material incorporated in a device or equipment for which a specific license is not required under the licensing procedures of the United States Nuclear Regulatory Commission or Agreement State.

3.13 High radiation area shall mean any area accessible to personnel in which there exists radiation at such levels that a major portion of the body could receive, in any one hour, a dose in excess of 100 millirems.

3.14 Industrial Establishments shall include manufacturing establishments, factories, workshops, mechanical establishments including nuclear power plants, laboratories, mercantile establishments, and all other buildings or

parts thereof where manufacturing, assembly, storage, research, testing, transfer and removal are carried on.

3.15 Ionizing Radiation shall mean and include alpha and beta particles, protons, neutrons, electrons, gamma and X-ray, and all other radiations which produce ionization directly or indirectly.

3.16 Installation shall mean the area of radiation hazard under the administrative control of the person or organization possessing the source of radiation. A part of or an entire industrial establishment may be designated as an installation.

3.17 Maximum Permissible Exposure shall mean that amount of exposure to radiation set for regulatory purposes, which in the light of present knowledge is not expected to cause appreciable bodily injury to a person during his lifetime.

3.18 Mercantile Establishments shall mean any premises used for the purposes of trade, in the purchase or sale of any goods or merchandise.

3.19 Place of employment shall mean every place, whether indoors or out, or underground, and the premises appurtenant thereto, into, in or upon which any employee goes, or remains, either temporarily or regularly in the course of his employment.

3.20 Rad shall mean the standard unit used in measuring the dose of any ionizing radiation to body tissues in terms of the energy absorbed per unit mass of the tissue. One rad is the dose corresponding to the absorption of 100 ergs per gram of tissue. (One millirad (mrad) = 0.001 rad.)

3.21 Radiation area means any area, accessible to individuals, in which there exists radiation at such levels that a major portion of the body could receive in any one hour a dose in excess of 5 millirems, or in any 5 consecutive days a dose in excess of 100 millirems.

3.22 Radiation Machine shall mean any device, instrument, equipment, or machine which may emit any of the radiation as defined herein.

3.23 Radioactive Material shall mean any material, either solid, liquid, or gas, which emits ionizing radiation spontaneously.

3.24 Radiation Safety Officer shall mean a person (s) who, to the satisfaction of the Commissioner, by training and experience having sufficient knowledge of radiation problems and the control of health hazards, is able to perform dependable radiation protection surveys, and has been sufficiently instructed and trained to manage the application of all protective techniques applicable to the control of radiation hazards within an installation, and to assume all responsibilities required of him by these rules and regulations.

3.25 Rem shall mean a measure of the dose of any ionizing radiation to body tissue in terms of its estimated biological effect relative to a dose of one roentgen (R) of x-rays. (One millirem = 0.001 rem). For the purpose of these regulations, any of the following is considered to be equivalent to a dose of one rem:

(1) An exposure of 1 R of X, or gamma radiation.

(2) A dose of 1 rad due to X, gamma, or beta radiation.

(3) A dose of 0.05 rad due to particles heavier than protons and with sufficient energy to reach the lens of the eye.

(4) A dose of 0.1 rad due to neutrons or high energy protons.

3.26 Roentgen (R) shall mean the special unit of exposure. One roentgen (R) equals 2.58×10^{-4} coulombs/kilogram of air. A common sub-multiple is the milliroentgen, (mR), which is one thousandth part of the roentgen, (R).

3.27 Sealed source shall mean any radioactive material that is permanently bonded or fixed in a capsule or matrix designed to prevent release and dispersal of the radioactive material under the most severe conditions which are likely to be encountered in normal use and handling.

3.28 Survey shall mean the evaluation of the radiation hazard incident to the use, handling, processing, application, transfer, storage, and disposal of all sources, materials, instruments, machines, and equipment which produce, generate, or emit ionizing radiation.

4. REGISTRATION

4.1 Registration requirements under this section shall apply to, but not be limited to manufacturing, mechanical and mercantile establishments, factories, workshops, construction, repair and alteration work and related operations.

4.2 The employer of every installation named in Section 4.1 shall register the same, or cause it to be registered with the Commissioner before it is placed in operation. Such registration shall be in writing in a form acceptable to the Commissioner, and shall include the following:

(a) The name and address of the employer.

(b) A designation of the confines of the installation.

(c) A designation of the type or types of sources of radiation in, or expected to be in the installation. (For example, X-ray machines, particle accelerators, sealed radioactive sources, unsealed radioactive material).

(d) For each type of source designated in (c), an estimate of the maximum number of sources of radiation expected to be in the installation at any one time, and an estimate of the maximum size or rating of such sources of radiation (For example: five X-ray machines, maximum rating 250 kilovolts, 5 milliamperes; 75 sealed cobalt^{60} sources 15 millicuries each; 15 millicuries of unsealed strontium^{90}).

(e) The name, address, qualifications, and signature of the Radiation Safety Officer (s), or other person in charge of radiation protection for the installation.

4.3 The employer, or Radiation Safety Officer, shall make a report, in writing to the Commissioner within seven days of:

(a) Any additions of sources of ionizing radiation which would alter the allowable inventory of sources recorded on the registration.

(b) Removal of all sources of ionizing radiation from the registered installation.

(c) Any changes or modification of installations, safety devices, personal protective equipment, work rules or operating conditions which may substantially increase the occupational hazard to employees.

4.4 The employer of every registered installation shall advise the Commissioner prior to use of all changes which may substantially increase the potential radiation hazard to any person.

4.5 Acknowledgment of registration shall not imply the approval by the Commissioner of such an installation, but shall merely indicate that the Department has a record of such installation.

4.6 Registration of an installation with the Department of Public Health may be deemed to meet the provision of Section 4.

5. EMPLOYEE QUALIFICATIONS

5.1 No employer shall suffer or permit an employee under eighteen years of age to work at or in the immediate vicinity of any operation in which there is the production, generation, or emission of ionizing radiation such as to cause the employee to receive an external exposure in excess of ten per cent (10%) of the limits specified in Appendix 2, or to be exposed to airborne concentrations of radioactive material in excess of limits specified in Table II, Appendix B of Title 10 of the Code of Federal Regulations, Part 20. For the purpose of this section concentrations may be averaged over periods not greater than a week.

5.2 Every employee shall be instructed in the observation of such sections of these rules and regulations as affect or concern the health and safety of employees. In providing instruction about health protection problems associated with radiation exposure, female workers and those who may supervise or work with them should be given specific instruction about prenatal exposure risks to the developing embryo and fetus.

5.3 Every employee and every person having supervision of employees shall be responsible for the observance of such rules and regulations as concern or affect the health and safety of employees.

5.4 No employer shall suffer or permit an employee who, on examination by a licensed physician or dentist, as specified in Section 12.1, has been shown to have an illness which may be aggravated thereby, to work at or in the immediate vicinity of any operation during the production, generation, or emmission of ionizing radiation such as to cause the employee to receive an exposure in excess of ten percent (10%) of the limits as specified in Appendix 2 and Section 6.3.

6. MAXIMUM PERMISSIBLE EXPOSURE

6.1 The exposure of persons to internal and external ionizing radiation shall be kept at the lowest practicable level. All unneccessary exposure to ionizing radiation shall be avoided.

6.2 Except as provided below, no employer shall suffer or permit an employee to receive in the course of his work a dose from radiation sources outside the body greater than those specified in Appendix 2.

6.3 Rates of radiation dose to the tissues of the body from radioactive materials within the body shall be controlled by limiting the average rates at which radioactive materials are taken into the body by inhalation, ingestion, or otherwise. No employer shall suffer or permit an employee to work in an atmosphere where the concentration of airborne radioactive materials averaged over thirteen weeks exceeds a level which, if inhaled continuously during a calendar quarter work period

will result in an effective radiation exposure to the body or any organ thereof greater than the amount specified in Appendix 2, unless the employee is supplied with, and required to use, appropriate protective equipment. Table I, Appendix B of Title 10 of the Code of Federal Regulation, Part 20, may be used to determine maximum airborne concentrations to which individuals eighteen years of age, or older, may be exposed.

6.4 When employees are exposed to radiation from both external and internal sources, either simultaneously or successively, the aggregate dose to any organ shall not exceed 100 per cent of the pro-rated amounts in 6.2 and 6.3.

6.5 Notwithstanding the provisions of 6.2, 6.3, and 6.4, an employer may, during any calendar quarter, suffer and permit an employee over eighteen years of age to receive a quarterly dose greater than a permissible quarterly dose subject to the following requirements:

(a) During any calendar quarter a dose to the whole body from sources of radiation in the employer's possession, shall not exceed 3 rems; and

(b) The dose to the whole body, when added to the accumulated occupational dose to the whole body, shall not exceed 5 (N-18) rems where "N" equals the individual's age in years at his or her last birthday; and

(c) The employer has determined the individual's accumulated occupational dose and records of such determinations are available for inspection by representatives of the Department.

6.6 Radiation Outside Control Area. The employer shall shield, isolate, protect or otherwise arrange and control every source so that the radiation dose received

by an individual outside the installation cannot exceed 10% of the limits specified in Appendix 2 and Section 6.3.

7. SURVEYS

7.1 Every employer shall make or cause to be made such surveys by or under the direction of a Radiation Safety Officer to determine whether the dose of ionizing radiation to any employee is maintained within the limits prescribed by the rules and regulations.

7.2 Every employer shall supply appropriate personnel monitoring equipment to, and shall require the use of such equipment by:

(a) Each individual who enters a controlled area under such circumstances that he or she receives, or is likely to receive, a dose in any calendar quarter in excess of 25 per cent of the applicable value specified in Appendix 2.

(b) Each individual under eighteen years of age who enters a controlled area under such circumstances that he or she receives, or is likely to receive, a dose in any calendar quarter in excess of 5 percent of the applicable value specified in Appendix 2.

(c) Each individual who enters a high radiation area.

7.3 Monitoring of the atmosphere within the installation for radiation or radioactive content may be required by the Commissioner or his representatives when there is any reasonable probability that the average levels of activity may exceed one-tenth (1/10) the amount specified in Section 6.3. Measurements averaged over a maximum period of thirteen weeks shall be permissible, but in any case there shall be sufficient monitoring to insure control of all radiation hazards.

7.4 The employer shall make or cause to be made in-vivo measurements and/or suitable tests of the radioactivity of exhaled breath, urine, or other biological specimens from employees who may have been expected to have ingested, inhaled or otherwise taken in radioactive material in excess of 25% of the limits specified in Section 6.3.

7.5 Each liquid or solid sealed source shall be tested for leakage before being placed in use and thereafter shall be tested for leakage at intervals not to exceed six months, unless specifically exempted by the Commissioner. Any registered sealed source is exempt from such leak tests when the source contains 100 microcuries or less of beta and/or gamma emitting material, or 10 microcuries or less of alpha emitting material. If the sealed source is found to be leaking in an amount greater than 0.005 microcurie, the employer shall immediately withdraw the equipment involved from use and shall cause it to be decontaminated and repaired or to be disposed of in accordance with Section 13.7. The test sample shall be taken from the sealed source or from the surfaces of the device in which the sealed source is permanently or semi-permanently mounted or stored on which one might expect contamination to accumulate. Leak tests are not required for sources that are stored and not being used. Stored sources, however, shall not be used or transferred unless leak tested within 6 months.

8. RECORDS

8.1 A record shall be made of each survey or test made under Section 7, and shall be signed by the person by or under whose direction it was made and shall be approved by the Radiation Safety Officer, and shall show the date when the survey or test was completed. These records shall be kept available for inspection by representatives of the Department, and a copy furnished to the Commissioner upon request. Each registrant shall also maintain accurate and complete records, as follows:

8.1

(a) The results of each required instrument calibration, survey and test.

(b) Each receipt, transfer to another installation, and disposal of a source of ionizing radiation.

(c) Radiation exposures of all individuals monitored. The doses recorded shall include calendar quarter totals.

8.2 Records shall be kept of the amount, kind, place, and disposition of any source of ionizing radiation used by an employer outside an installation. These records shall be kept available for inspection by representatives of the Department, and a copy furnished to the Commissioner upon request.

8.3 No person shall damage or destroy any required records as specified in 8.1 and 8.2, or suffer or permit the same to be destroyed without first having obtained the written consent of the Commissioner. All pertinent radiation exposure records or copies thereof shall be readily available to the attending physician of any person who may have undergone exposure in connection with the installations to which such records relate.

8.4 At the request of any employee, each employer shall furnish such employee annually or within 30 days after termination, a summary of the employee's exposure to radiation or radioactive material.

8.5 Upon termination of employment of a person, the Commissioner shall, upon request, be supplied with a summary statement of that person's total radiation dose received as a result of employment. (The estimated maximum dose shall be stated, if no employee monitoring has been carried out). This summary shall include statements of any circumstances wherein the dose to the employee, from any source of radiation, exceeded those specified in these rules and regulations.

8.6 The Commissioner shall receive all radiation records of a discontinued radiation installation which are voluntarily presented to him by the employer and acknowledge the receipt thereof in writing. The delivery of such records to the Commissioner relieves the employer from subsequent responsibility in respect to the keeping of these records. The Commissioner may keep or destroy such records at his discretion.

9. NOTIFICATION OF INCIDENTS

9.1 The employer, or Radiation Safety Officer, shall notify the Commissioner within twenty-four hours by telephone, or telegraph, and shall make an immediate report in writing to the Commissioner of any incident involving sources of radiation under his administrative control which may have caused, or threatens to cause:

(a) An exposure to the whole body of any individual to 5 rems or more of radiation; exposure to the skin of the whole body of any individual of 30 rems or more of radiation; or exposure to the feet, ankles, hands, or forearms to 75 rems or more of radiation.

(b) The release of radioactive material in concentrations which if averaged over twenty-four hours would exceed 500 times limits specified in Section 6.3.

9.2 The employer, or Radiation Safety Officer, shall notify the Commissioner within twenty-four hours, by telephone or telegraph, and shall make an immediate report, in writing to the Commissioner of:

(a) The loss or theft of any source of ionizing radiation.

(b) Fires, explosions or other accidents where it is known, or believed that radioactive material has been involved.

9.3 The employer, or Radiation Safety Officer, shall make a report, in writing, to the Commissioner within thirty days of each exposure to an individual to radiation or concentrations of radioactive materials in excess of applicable limits as given in appropriate sections and appendices referring to permissible exposure or concentrations in air.

9.4 Each report required under 9.1, 9.2, and 9.3 shall describe the extent of exposure to persons to radiation or to radioactive materials; levels of radiation and concentrations of radioactive material involved; the cause of the exposure, levels or concentrations and corrective steps taken or planned to assure against a recurrence.

10 WARNING SIGNS AND LABELS

10.1 Except as provided in 10.8 and 14, the employer shall indicate the presence of each source of radiation by conspicuous labels on the source or container thereof or by conspicuous warning signs in their immediate vicinity, or both

Radiation Symbol

1. Cross-hatched area is to be magenta or purple.
2. Background is to be yellow.

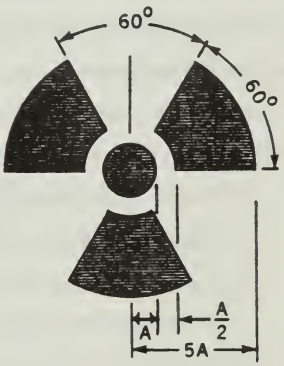

Figure 1

10.2 Each sign or label in the vicinity of the source shall bear the standard warning symbol as specified in 10.6 and the word "CAUTION" or "DANGER" and appropriate explanatory wording such as

RADIATION AREA

HIGH RADIATION AREA

AIRBORNE RADIOACTIVITY AREA

X-RAY AREA

10.3 Each sign or label on the source or container shall bear the standard warning symbol specified in 10.6 and the words "CAUTION" or "DANGER", and the words "RADIOACTIVE MATERIAL." Each sign or label shall state the quantities and kinds of radioactive material and the date of assay.

10.4 The printing on each sign, or label, shall be in CAPITOL BLOCK LETTERS. The printing or other matter on such sign, or label shall not obliterate the symbol or the wording required in Sections 10.2 and 10.3.

10.5 Where, in the judgment of the Radiation Safety Officer or the Commissioner or his representative, personnel monitoring or the use of respiratory equipment is required for employees entering a radiation area or installation, the posted signs shall conspicuously indicate such requirements.

10.6 The standard warning symbol as described below is hereby adopted:

(a) Upon a yellow background there shall be the design in purple (magenta) shown in Figure 1.

(b) The design in purple/magenta must be centered within a sufficient area of yellow background to make it conspicuous.

(c) Regardless of the size in which such symbol may be made, the proportions shown in Figure 1 shall be maintained.

10.7 No person shall affix, post, or display any sign or label bearing such standard radiation warning symbol or any closely similar symbol to, upon, or in any thing or location in any place to which these rules and regulations apply except for the purpose of warning of the presence of ionizing radiation.

10.8 Warning signs are not required to be posted at areas or rooms containing sources of radiation for periods of less than one (1) full work day, provided such sources are attended by a radiation worker during such periods.

10.9 All machines, instruments, devices, or equipment generating, producing, or emitting X-rays shall be labeled conspicuously as follows:

CAUTION--X-RAYS

This Equipment Produces X-Rays When Energized

(Labels as required under the Federal Food, Drug and Cosmetic Act may be substituted for the above label).

10.10 All machines, instruments, devices, or equipment generating, producing, or emitting ionizing radiation, other than X-rays, when energized shall be labeled conspicuously as follows:

CAUTION--RADIATION

This Equipment Produces Ionizing Radiation When Energized

10.11 No person shall knowingly remove, destroy, obscure or deface any warning sign or label required under section 10.

11. STORAGE

11.1 Radioactive material not in use shall be stored in properly labeled and shielded containers secured against unauthorized access or removal.

11.2 Vaults or rooms used for storing materials which may emit radioactive gases shall be suitably ventilated to conform with Section 6.3.

11.3 When there is any probability that chemical, radiation, or other action might weaken or rupture the container of radioactive materials sufficiently to cause leakage therefrom, the container shall be provided with a suitable secondary tray or catchment adequate to retain the entire amount of radioactive material.

11.4 Storage containers for radioactive material in excess of 1,000 times the amounts specified in Appendix 1 shall be designed to be resistant to fire and earthquake damage, and to maintain reasonable temperatures. Containers shall be structurally sound over the period of intended use with due regard to corrosion, radiation, and temperature effects thay may develop.

11.5 Suitable provision shall be made to minimize the radiation hazard to emergency workers in the event of fire, and in situations where earthquake, flood, and windstorm potentials exist.

12. MEDICAL EXAMINATIONS

12.1 An appropriate medical examination shall be given to any person prior to his assignment in an operation where he receives, or is likely to receive, a dose in any calendar quarter in excess of 25% of the values specified in the table in Appendix 2, or who will be exposed to airborne radioactive material in an average concentration in excess of 10% of the limits specified in Section 6.3, and thereafter at least once a year during such assignment, and when feasible, at the termination of such assignment.

12.2 The medical examination as described in 12.1 shall include such laboratory studies as the Commissioner may specify, and shall be repeated at more frequent intervals when specified by the Commissioner.

12.3 Records of the medical examinations and laboratory studies shall be kept available by the employer for inspection by representatives of the Department.

13. GENERAL

13.1 No work with materials, instruments, machines, devices, or equipment which produce, generate, or emit ionizing radiation shall be given out as industrial homework, nor shall any contract or sub-contract work be performed in any place other than a registered installation.

13.2 Before any person hereafter employed is permitted to use, handle, process, apply, transfer, store, or dispose of any source of material, or operate or use any instrument, machine, device, or equipment emitting, generating, or producing ionizing radiation, such person shall be given preliminary training and instructions, which shall include practice in the safe handling and use of substances, the use of tools, the operation of the instrument, machine, device, or equipment, the use and care of protective clothing and equipment, the proper methods of personal hygiene, and emergency radiation control measures.

13.3 The employer shall provide and require the use of such adequate health and safety procedures, safety devices, and protective clothing as deemed necessary by the Commissioner to protect the employee against excessive external exposure, excessive inhalation, ingestion or other absorption and contamination by sources of ionizing radiation.

13.4 Smoking shall be prohibited and no food, including candy and beverages, shall be brought into or consumed in areas where unsealed sources of radioactive material are being used, handled, stored, processed or transferred. Specific notice to

this effect shall be posted conspicuously in such areas.

13.5 At least 250 cubic feet of air space shall be provided each employee working in rooms or other installations where materials, sources, instruments, machines, devices, and equipment which produce, generate or emit ionizing radiation are used.

13.6 The employer shall, if so required by the Commissioner, provide, within reasonable access to work areas, facilities satisfactory to the Commissioner for the removal and control of contamination to the employees by radioactive material. The facilities shall consist of such wash basins and shower baths, with ample supply of hot and cold running water, lockers, change rooms and other equipment as may be deemed necessary by the Commissioner.

13.7 The employer may dispose of radioactive waste by dumping or burial only in areas and by procedures approved by the Department or by other proper agencies having jurisdiction over such matters.

13.8 Procedures for picking up, receiving, and opening packages containing radioactive materials in excess of the exempt limits shall be in accordance with 10 CFR 20.205 (Title 10, Code of Federal Regulations, Part 20, Section 205).

13.9 Registrants possessing radioactive materials shall prepare a written plan delineating procedures to be followed in the event of an emergency. such as a spill, fire, release or loss of material, or accidental contamination of personnel. The plan shall also include the names and telephone numbers of persons who are to be notified.

13.10 Registrants shall notify the local fire department of the presence on the premises of any radioactive material that may present special fire-fighting problems or require special precautionary measures in case of fire or other natural catastrophe, and shall establish effective liaison with the fire department in regard to this matter.

14. EXEMPTIONS

14.1 Except as specifically provided for in these Rules and Regulations, every installation involving only the following devices, equipment, and materials are hereby exempted from the application of these Rules and Regulations:

(a) Electrical equipment that produces ionizing radiation incidental to its operation for other purposes, providing that the dose does not exceed 10% of limits specified in Appendix 2.

(b) Domestic television receivers, except during production testing.

(c) Potentially radiation-producing equipment which is not being used or operated in such a manner as to produce radiation, e.g., during storage, shipping or during the course of retail sale. Such equipment is not exempted from the labeling requirements of these Rules and Regulations.

(d) Any radioactive material being transported by common carrier and subject to the jurisdiction of the Interstate Commerce Commission or other governmental agency having jurisdiction.

(e) Radioactive materials of a degree of specific radioactivity approximately equivalent to that of natural potassium (0.001 microcurie/gram).

(f) Timepieces, instruments, equipment, or devices containing self-luminous elements during the course of retail sale, during industrial use, or during repair. The repair and refinishing of the self-luminous elements themselves are not exempted.

(g) The possession, use or storage of the quantities listed in Appendix I, provided that no installation shall, at any one time possess, store or use more than a total of ten such listed quantities. This exemption does not include the waste disposal requirements of Section 13.7.

(h) Radioactive material contained in smoke, gas or aerosol detectors designed to protect life or property from fires or airborne hazards.

(i) Electronic tubes which contain radioactive material consisting of not more than 150 millicuries of tritium per microwave receiver protector tube or 10 millicuries of tritium per any other electron tube; or 1 microcurie of Cobalt-60; or 5 microcuries of Nickel-63; or 30 microcuries of Krypton-85; or 5 microcuries of Cesium-137; or 30 microcuries of Promethium-147.

(j) Devices designed for use in measuring or determining light intensity which contain as a sealed source of sources, radioactive material consisting of a total of not more than 200 microcuries of Strontium-90 per device.

(k) Devices designed for use as static eliminators or for ionization of air which contain a sealed source or sources of radioactive material consisting of a total of not more than 500 microcuries of Polonium-210 per device, or a total of not more than 50 millicuries of hydrogen-3 (tritium) per device.

(l) Compasses containing not more than 750 millicuries of tritium gas and other navigational instruments containing not more than 250 millicuries of tritium gas.

(m) Automobile shift quadrants containing not more than 25 millicuries of tritium.

(n) Thermostat dials and pointers containing not more than 25 millicuries of tritium per thermostat.

(o) Any radioactive material that is exempted from the requirements of Parts 19 and 20 of Title 10, Code of Federal Regulations.

(p) Other Exemptions: The Commissioner may, upon application of any interested person or upon his/her initiative, grant such exemptions from these Rules and Regulations and from the requirement of registration as he/she determines are authorized by law and will not constitute a significant risk to the health and safety of the public.

Note: The manufacture or repair of the radioactive component in the devices and equipment in sub-sections h,i,j,k,l,m and n is not exempt.

14.2 Nothing in these Rules and Regulations shall be construed to limit the kind and amount of ionizing radiation that may be intentionally applied to a person for diagnostic or therapeutic purposes by, or under the direction of, a licensed physician or dentist.

15. PENALTY

15.1 Whoever violates any reasonable rule, regulation or requirement made by the Department under authority hereof shall except as hereinafter provided, be punished by a fine of not more than one hundred dollars ($100) for each offense, and whoever violates any such rule, regulation or requirement

for the prevention of industrial or occupational diseases caused by ionizing radiation shall be punished by a fine of not more than five hundred dollars ($500.) for each offense (Section 6 of Chapter 149 of the General Laws).

APPENDIX I

Exempt Possession Limits

The following quantities of radioactive material are exempt from the application of these rules and regulations pursuant to Section 14.1 (g).

Radioactive Material	Unsealed (Microcuries)	Sealed (Microcuries)
Americium 241 (Am 241)	.1	1
Antimony 122 (Sb 122)	10	50
Antimony 124 (Sb 124)	1	10
Antimony 125 (Sb 125)	1	10
Argon 37 (Ar 37)	100	100
Arsenic 74 (As 74)	10	50
Arsenic 76 (As 76)	10	50
Arsenic 77 (As 77)	10	50
Barium 131 (Ba 131)	10	50
Barium 133 (Ba 133)	10	50
Barium 140 (Ba 140)	1	50
Beryllium 7 (Be 7)	50	50
Bismuth 207 (Bi 207)	.1	1
Bismuth 210 (Bi 210)	.1	1
Bromine 82 (Br 82)	10	50
Cadmium 109 (Cd 109)	10	50
Cadmium 115 (Cd 115)	10	50
Cadmium 115m (Cd 115m)	10	50
Calcium 45 (Ca 45)	10	50
Calcium 47 (Ca 47)	10	50

Radioactive Material	Unsealed (Microcuries)	Sealed (Microcuries)
Carbon 14 (C14)	50	100
Cerium 141 (Ce 141)	100	100
Cerium 144 (Ce 144)	.1	1
Cesium 129 (Cs 129)	100	100
Cesium 131 (Cs 131)	1,000	1,000
Cesium 134 (Cs 134)	1	10
Cesium 137 (Cs 137)	1	10
Chlorine 36 (Cl 36)	1	10
Chromium 51 (Cr 51)	50	50
Cobalt 57 (Co 57)	10	50
Cobalt 58 (Co 58)	10	50
Cobalt 60 (Co 60)	1	10
Copper 64 (Cu 64)	50	50
Dysprosium 159 (Dy 159)	100	100
Erbium 169 (Er 169)	100	100
Europium 152 (Eu 152)	1	10
Europium 154 (Eu 154)	1	10
Europium 155 (Eu 155)	1	10
Fluorine 18 (F 18)	50	50
Gadolinium 153 (Gd 153)	10	50
Gallium 67 (Ga 67)	100	100
Gallium 68 (Ga 68)	10	50
Gallium 72 (Ga 72)	10	50
Germanium 71 (Ge 71)	50	50
Gold 195 (Au 195)	10	50

Radioactive Material	Unsealed (Microcuries)	Sealed (Microcuries)
Gold 198 (Au 198)	10	50
Gold 199 (Au 199)	10	50
Hafnium 181 (Hf 181)	10	50
Holmium 166 (Ho 166)	100	100
Hydrogen 3 (H 3)	1,000	1,000
Indium 111 (In 111)	100	100
Indium 113m (In 113m)	100	100
Indium 114m (In 114m)	1	10
Iodine 125 (I 125)	1	10
Iodine 129 (I 129)	.1	1
Iodine 131 (I 131)	10	50
Iridium 192 (Ir 192)	10	50
Iron 52 (Fe 52)	10	50
Iron 55 (Fe 55)	50	100
Iron 59 (Fe 59)	1	10
Krypton 85 (Kr 85)	100	100
Lanthanum 140 (La 140)	10	50
Lead 210 (Pb 210)	10	50
Lutetium 177 (Lu 177)	100	100
Manganese 54 (Mn 54)	10	50
Mercury 197 (Hg 197)	100	100
Mercury 197m (Hg 197m)	100	100
Mercury 203 (Hg 203)	10	50
Molybdenum 99 (Mo 99)	10	50
Neodymium 147 (Nd 147)	100	100

Radioactive Material	Unsealed (Microcuries)	Sealed (Microcuries)
Nickel 59 (Ni 59)	1	10
Nickel 63 (Ni 63)	1	10
Niobium 95 (Nb 95)	10	50
Osmium 191 (Os 191)	100	100
Palladium 103 (Pd 103)	50	50
Phosphorus 32 (P 32)	1	10
Plutonium 239 (Pu 239)	0.1	1
Polonium 210 (Po 210)	0.1	1
Potassium 42 (K 42)	10	50
Praseodymium 142 (Pr 142)	100	100
Praseodymium 143 (Pr 143)	10	50
Promethium 147 (Pm 147)	10	50
Protactinium 233 (Pa 233)	10	50
Protactinium 234	100	100
Radium 226 (Ra 226)	0.1	1
Rhenium 186 (Re 186)	10	50
Rhodium 105 (Rh 105)	100	100
Rubidium 86 (Rb 86)	10	50
Rubidium 87 (Rb 87)	10	50
Ruthenium 97 (Ru 97)	100	100
Ruthenium 103 (Ru 103)	10	50
Ruthenium 106 (Ru 106)	1	10
Samarium 151 (Sm 151)	100	100
Samarium 153 (Sm 153)	10	50

Radioactive Material	Unsealed (Microcuries)	Sealed (Microcuries)
Scandium 46 (Sc 46)	1	10
Selenium 75 (Se 75)	10	50
Silver 105 (Ag 105)	1	10
Silver 110m (Ag 110 m)	1	10
Silver 111 (Ag 111)	10	50
Sodium 22 (Na 22)	10	50
Sodium 24 (Na 24)	10	50
Strontium 85 (Sr 85)	10	50
Strontium 89 (Sr 89)	1	10
Strontium 90 (Sr 90)	0.1	1
Sulfur 35 (S 35)	50	50
Tantalum 182 (Ta 182)	10	50
Technetium 99 (Tc 99)	1	10
Technetium 99m (Tc 99m)	10	100
Tellurium 129 (Te 129)	1	10
Tellurium 132 (Te 132)	1	10
Terbium 160 (Tb 160)	1	10
Thallium 204 (Tl 204)	50	50
Thorium (natural)	500	500
Thulium 170 (Tm 170)	10	50
Tin 113 (Sn 113)	10	50
Tin 119m (Sn 119m)	50	50
Titanium 44 (Ti 44)	50	50
Tungsten 185 (W 185)	10	50

Radioactive Material	Unsealed (Microcuries)	Sealed (Microcuries)
Uranium (natural)	500	500
Uranium 233 (U 233)	.1	1
Uranium 234-235 (U234-235)	1	10
Uranium depleted (U 238)	500	500
Xenon 133 (Xe 133)	100	100
Ytterbium 169 (Yb 169)	100	100
Yttrium 87 (Y87)	1	10
Yttrium 90 (Y90)	1	10
Yttrium 91 (Y 91)	1	10
Zinc 65 (Zn 65)	1	10
Zinc 69 (Zn 69)	100	1,000
Zirconium 95 (Zr 95)	10	50
Alpha-emitting radioactive material, other than special nuclear material, not listed above	0.1	1
Radioactive material, other than alpha emitting material, not listed above:		
With Half life > 30 days	1	10
With Half life ≤ 30 days	10	50

APPENDIX 2

Permissible Dose

Except as provided in Section 6.5, no employer shall possess, use or transfer sources of ionizing radiation in such a manner as to cause any individual in a controlled area to receive from radioactive material and/or other sources of radiation under his or her administrative control a dose in excess of the limits specified in the following table:

PART OF BODY	MAXIMUM DOSE PERMITTED IN ANY CALENDAR YEAR	MAXIMUM DOSE PERMITTED IN ANY CALENDAR QUARTER
Whole Body Gonads Active Blood Forming Organs Lens of Eye Head and Trunk	5 rems	1.25 rems
All Organs, Including thyroid, other than those above	15 rems	5.0 rems
Skin of Whole Body	30 rems	7.5 rems
Hand and Forearms Feet and Ankles	75 rems	18.75 rems

"Exposure of the Fetus of Fertile Women"

During the entire gestation period, the maximum permissible dose equivalent to the Fetus from occupational exposure of the expectant mother shall not exceed 0.5 rem.

Maximum dose values are derived from Title 10, Code of Federal Regulations, Part 20 (10 CFR 20) and the National Council on Radiation Protection and Measurements (NCRP) Publication No. 39.

APPENDIX 3

Neutron Dose Equivalent to One Rem

For the purpose of these Rules and Regulations a dose of 0.1 rad due to neutrons is equivalent to one rem. If it is more convenient to measure the neutron flux or equivalent than to determine the neutron dose in rads, one rem of neutron radiation may be assumed to be equivalent to 14 million neutrons per square centimeter incident upon the body; or if there exists sufficient information to estimate with reasonable accuracy the approximate distribution in energy of the neutrons, the incident number of neutrons per square centimeter equivalent to one rem may be estimated from the following table:

Neutron energy (Mev)	Number of Neutrons per square centimeter equivalent to a dose of 1 rem (Neutrons/cm^2)	Average flux to deliver 100 millirem in 40 hours (neutrons/cm^2 per sec.)
Thermal	970×10^6	670
0.0001	720×10^6	500
0.0005	820×10^6	570
0.02	400×10^6	280
0.1	120×10^6	80
0.5	43×10^6	30
1.0	26×10^6	18
2.5	29×10^6	20
5.0	26×10^6	18
7.5	24×10^6	17
10	24×10^6	17
10 to 30	14×10^6	10